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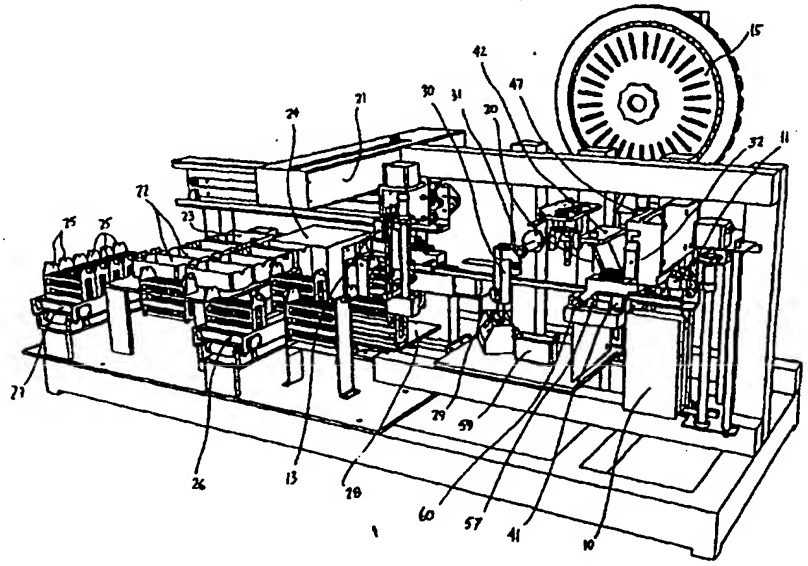
(57) Abstract

A closed tube sampling apparatus (14) for drawing a specimen sample tube (16) having a pierceable cap comprises a tube loading carousel (15) in which sample tubes are radially disposed and indexed in turn to an aspirate position. A needle carrier (42) is moveable linearly to move an aspirate needle (17) from a park position where the needle is in a wash station (47) to an aspirate position where the needle extends through said wash station and pierces said cap for the purpose of aspirating a sample from the tube. The needle wash station is also moveable relative to the needle carrier and is spring (49) biased to bear on said cap and prevent withdrawal of the cap as said needle is withdrawn. A dispensing pipette (20) is in fluid communication with said needle and subsequently dispenses said sample onto a slide. A slide transfer apparatus for sequentially transferring single slides (40) from a stack of slides onto a slide conveyor (12) includes a pickup head (11) having a bellows type suction cup (39) for lifting and holding slides. A fixed optical sensor (34) detects a home position of the pickup head and the travelling optical sensor (36) on the head detects when a slide is held and released from the head. The degree of movement of the head in releasing a slide is detectable by the travelling sensor (36) and thereby a microprocessor is able to determine whether one or two slides have been transferred by the head from the stack to the conveyor. The amount of movement of the head from the home position to the top of the stack and from the home position to the top of the conveyor is also determined by the microprocessor which in determining all movements counts the revolutions of a stepper motor which is responsible for such movement.



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TITLE: SPECIMEN PREPARATION

The present invention relates to a specimen preparation apparatus. Various inventive elements of a specimen preparation apparatus are also disclosed. In particular, although not exclusively, the invention relates to a fully automated blood film making and staining apparatus. However, the invention is not restricted to use in preparing blood specimens but may also have application in preparing other types of specimens to be examined in a laboratory.

A significant volume of the specimens processed in clinical laboratories are blood specimens. Blood may be examined under a microscope by creating a blood film which is a thin film of blood on a glass microscope slide. In preparing the blood film, a laboratory technician firstly transfers the patient identification number from a sample tube onto the label of a microscope slide. Transcription errors are not uncommon. It is also important that finger or glove prints do not contaminate the surface of the slide.

The gloved technician then removes the cap of the sample tube and a blood sample is removed from the tube and placed at one end of a clear area of the slide. A glass smearer is then used to make the blood film. The smearer is like a normal microscope slide and may have the corners cut off. The smearer has a smooth ground edge which is placed on the slide and drawn back onto the drop of blood. The technician then pauses while the blood spreads across the face of the smearer. The technician then moves the smearer away from the blood drop in one rapid, smooth motion. The surface tension of the blood and adhesion of the blood to the glass smearer means that the drop is pulled along the slide resulting in a thin film of blood.

Following preparation of the blood film, the slide undergoes a staining process which involves immersing racks of slides in pots of stain for prescribed times. After staining, the films are dried and then passed to a haematologist for inspection.

Thus the above manually performed process involves risks in the handling of blood which are undesirable given the increased prevalence of HIV/AIDS and Hepatitis (A,B,C and D). Furthermore, there is a risk of transferring incorrect information to the microscope slide. Another disadvantage with the above process

is the precision yet tedium involved in preparing a large number of blood films and the tedium in processing the prepared blood films through the staining process.

It is therefore an object of the present invention to overcome or at least ameliorate one or more of the above-mentioned disadvantages.

Accordingly, one form of the invention provides a closed tube sampling apparatus for drawing a specimen sample from a sample tube having a pierceable cap, said apparatus including a sample tube loading carousel for supporting sample tubes radially on said carousel, characterised in that, said carousel is adapted to index said tubes in turn to an aspirate position; said apparatus further including a needle carrier moveable linearly from a park position to a range of operative positions located towards said carousel, said needle carrier including an aspirator needle for piercing said cap and drawing a sample; and a tube support member moveable linearly relative to said needle carrier towards and away from said carousel and being adapted in an extreme position in one direction to prevent withdrawal of said cap and tube from said carousel during sampling.

In another form the invention provides a slide transfer apparatus for transferring slides from a stack of slides to a slide conveyor, characterised in that, said apparatus includes a pickup head for picking up the top slide from a stack of slides and returning to a home position, a slide transport platen for movement under said pickup head to receive a slide from said pickup head, and a sensor on said pickup head to determine when said slide is released from said pickup head onto said platen and facilitate determination of whether one slide or several adhered slides are released onto said platen.

In order that the invention may be more fully understood, one embodiment will now be described with reference to the drawings in which:

Figure 1 is a perspective view of a blood film making and staining apparatus incorporating the present invention;

Figure 2 is a perspective front view of a closed tube blood sampling apparatus, constituting a portion of the overall blood film making and staining apparatus of Figure 1;

Figure 3 is a perspective rear view of the closed tube sampling apparatus of

Figure 2;

Figure 4 is an enlarged perspective view of the smearer chuck and smearing element as shown in Figure 1, the view illustrating the two axis of rotation provided for the smearing element; and

Figures 5–8 are schematic front elevations of the slide transfer mechanism of the apparatus of Figure 1 showing various positions of a slide pickup head.

The overall blood film making and staining apparatus is shown in Figure 1 and only those parts relevant to the present invention will be described in detail. The overall apparatus generally comprises a carousel based sample tube loading and mixing device, a slide transport system, a closed tube sampling apparatus, a blood film making device, a slide staining system, a slide rack handling system, a liquid supply and handling system, a waste liquid handling system, vacuum and air pressure supply and handling system, a slide identification system, a microprocessor control system, a user interface and various pressure and vacuum sensors. Each of the above parts of the apparatus will be referred to in more detail below.

The slide transport system consists essentially of a slide hopper 10, slide pickup head 11, a slide transport platen 12, a rack loading head 13, a vacuum pump (not shown) and an arrangement of vacuum valves and pipework (not shown) allowing the distribution of said vacuum as required.

The closed tube sampling apparatus is generally referenced 14 and is shown in more detail in Figures 2 and 3. The sampling apparatus 14 is for drawing a sample from a sample tube 16 in carousel 15 and comprises essentially a cap piercing aspirator needle 17, a needle stripping mechanism consisting essentially of stripping plate 18 and lug plate 19, a syringe pump (not shown), and a sample dispensing pipette 20.

The slide staining system consists essentially of a staining robot 21, staining tubs 22, a wash station 23 and a temperature controlled drying oven 24. The slide rack handling system essentially comprises slide racks 25, rack input conveyor 26, rack/slide output conveyor 27 and rack indexing mechanism 28.

The blood film making device consists essentially of a smearing element 29 and associated smearer chuck 30 and support arm 31. The smearing element 29 may

be glass or other material. The smearer chuck 30 is pivoted around two axes one parallel with the lengthwise axis of the smearing element 29, and one parallel with the widthwise axis of the smearing element 29 as more clearly shown in Figure 4. The smearing element 29 is free to pivot about the axis parallel with the widthwise axis of the smearing element which allows automatic alignment of the smearing element to the surface of a slide when presented to the slide surface. The smearer chuck 30 is spring loaded so as to be vertical in its rest state (as shown in Figure 1).

The liquid supply and handling system includes an external rinse solution supply bottle (not shown), an internal rinse solution supply reservoir (not shown), a liquid pump and an arrangement of valves and pipework (not shown) allowing the distribution of liquid as required, wash stations for the aspirator needle 17, sample dispensing pipette 20, and smearing element 29 respectively, and a smearer element wash station 58.

The waste liquid handling system comprises an external waste liquid bottle with level detection (not shown), an internal waste reservoir with level detection (not shown), a vacuum pump (not shown), and an arrangement of valves and pipework (not shown) to allow for the collection of said waste liquid.

The slide identification system comprises a bar code reader (not shown) and a dot matrix slide printer 32. A microprocessor control system and software (not shown) is provided to control all aspects of the apparatus operation. An uninterruptible power supply is preferably provided. The user interface incorporates a keypad and LCD display (not shown).

Furthermore, various pressure and vacuum sensors (not shown) are disposed so as to allow implementation of diagnostic and error handling functions.

To prepare the apparatus for operation, the user places up to 30 blood filled sample tubes into the tube loading carousel 15 by placing them in any one of a plurality of radial holes disposed symmetrically around the periphery of carousel 15.

The user can stack up to 150 painted label glass microscope slides into the slide hopper 10 and load up to six slide racks 25 into the rack input conveyor 26.

Processing of the blood samples is initiated by user input to the user interface panel (not shown). The instrument performs an initialisation routine that ensures that

all moving axes are in known positions.

In particular, Figures 5 – 8 assist in describing an initialisation routine undertaken by the slide transport system. The slide pickup head 11 is driven up and down by rotation of the lead screw 33 driven by a stepper motor (not shown). Two sensors are utilised with the operation of the slide pick up head 11. Firstly, a fixed sensor 34 is provided to determine when the slide pickup head 11 reaches the upper most limit of its travel. This uppermost limit is referred to as the home position or reference point. The fixed sensor 34 is tripped by a protrusion or flag 35 on the upper surface of the slide pickup head 11 which breaks an optical beam 61 in the sensor 34. Secondly, a travelling sensor 36 is provided on the slide pickup head 11. The travelling sensor 36 includes plunger flag 37 biased downwardly by the operation of spring 38. The travelling sensor 36 is tripped when something comes into contact with the underside of the slide pickup head 11 and hence into contact with the plunger flag 37. This causes the stem of plunger 37 to break beam 62 in the sensor 36.

During the initialisation sequence, the slide pickup head moves to the home position activating fixed sensor 34. The slide pickup head 11 then moves to touch the top of slide transport platen 12 whereupon travelling sensor 36 will be activated by the stem of plunger 37 breaking beam 62. The apparatus thus calculates the number of revolutions made by the stepper motor (not shown) in moving the slide pickup head from the home position to the position where the travelling sensor 36 is activated to thereby calculate the distance between the home position and the top of the transport platen 12. This parameter is stored in the apparatus by the microprocessor control system. In addition, the initialisation sequence also determines, in a similar manner, the location of the top slide in the slide hopper 10.

Returning to Figure 1, rotation of the tube loading carousel 15 causes blood samples in respective sample tubes 16 located in the carousel to be mixed.

The rack input conveyor 26 moves slide racks 25 to a pickup position at the inner end of the rack input conveyor 26. When a through beam type sensor pair confirms that a rack is at the rack pickup position then the staining robot 21 picks up the rack and places it onto the rack indexing mechanism 28. The rack indexing

mechanism 28 then moves the slide rack 25 to a position such that the rack is located below the rack loading head 13 and able to receive slides.

The slide pickup head 11 moves from its home position into the slide hopper 10 where the slides are arranged in a stack. The slide pickup head 11 comprises a bellows type suction cup 39 and the travelling sensor 36 (see Figures 5 – 8) that indicates the presence of a slide 40 on the head 11.

Picking up a slide is achieved by moving the slide pickup head 11 down towards the top of the stack of slides until it is almost in contact with the top slide 40 in the slide hopper 10. Taking slides from the top of the stack has the advantage that the mechanism does not have to work against the weight of the stack of slides.

As the pickup head 11 approaches the slide stack, vacuum is applied to the bellows suction cup 39 which is in its extended, or natural, state. Upon contacting the top slide of the stack, the bellows suction cup 39 is rapidly evacuated by the vacuum source causing it to collapse into a compressed state. In the process the top slide is grasped and rapidly accelerated away from the stack beneath. This rapid acceleration provides generally reliable separation of slides. Slides are grasped by the action of the suction cup on the label area of the slide only.

When the slide contacts the slide pickup head 11 the travelling sensor 36 detects its presence by breaking of the beam 62 by the plunger stem and the microprocessor controller reverses the motion of the slide pickup head 11 returning it to its home position as detected by the fixed sensor 34 where it is above the level of the platen 12.

The slide transport platen 12 then moves from its home position to a position directly under the slide pickup head 11 so as to receive the slide. The slide pickup head 11 moves down to a position close to the slide transport platen 12 and the slide is transferred to the platen by selective manipulation of the state of the vacuum valves. In other words the vacuum of the slide pickup head 11 is cut off causing the slide to be pressed down onto the platen. The slide is retained on the slide transport platen 12 by the action of a vacuum applied by the platen to the underside of the slide. The slide pickup head 11 now moves upwards towards the home position and the distance of upward travel required before the stem of plunger 37 no longer

breaks the beam 62 is used to determine if more than one slide has been placed on the platen 12 due to two slides being adhered together. If more than one slide has been transferred then the slide pickup head 11 returns to the platen 12 and vacuum is applied to both the pickup head 11 and the platen 12. The slides are thus pulled apart either by moving the slide pickup head 11 upwards or by moving the platen 12 horizontally. Horizontal movement of the platen 12 has been found more effective.

The tube loading carousel 15 ceases mixing the sample by rotation and comes to rest with a sample tube 16 disposed in an aspirate position vertically above the sampling needle 17 with the sample tube sealing cap (not shown) at the bottom. A bar code reader (not shown) confirms the presence of a tube in the aspirate position.

The bar code reader is mounted behind the tube loading carousel 15. An additional bar code label is attached to the carousel 15 itself in each tube position whereby insertion of a tube covers the additional label in that position. This label may read "No Tube" or any other identifier so desired.

If a tube with bar code is present, and the bar code label is visible and readable, the bar code reader outputs a "Read OK" indication and the label data. The enclosed data is then transmitted to the slide printer 32 via the microprocessor controller.

If no tube is present the bar code reader outputs a "Read OK" indication and the data "No Tube" identifier indicating that there is no tube in this position.

If a tube having a damaged, missing, or incorrectly applied bar code label is present then the bar code reader will output a "Bad Read" indication.

The system thus allows the detection of the presence of tubes using a bar code reader.

The slide transport platen 12 having received a slide moves to a position so that the slide label is positioned beneath the printing head of the dot matrix type slide printer 32. The slide transport platen 12 is pivoted a few degrees to raise an end of the platen so as to present the label of the slide to the printing face of the slide printer 32. The rotation may be up to 10 degrees. This rotation is caused by the presence of magnetic elements arranged so as to produce a repulsive force

between the slide transport platen 12 and the frame or chassis of the apparatus. A large magnet 41 is located underneath the slide printer 32 and a smaller magnet (not shown) is disposed in the slide transport platen 12. These magnets repel each other so that as the platen 12 moves beneath the printer 32, the platen 12 is caused to pivot a few degrees so that the label end of the slide contacts the printer 32. The slide printer 32 prints the sample tube identifying number, and other text requested by the user, onto the label portion of the slide.

Following confirmation of the presence of a tube, the sampling needle 17 moves upwards and pierces the rubber sealing cap of the sample tube 16 in the aspirate position. Sampling is initiated. The sampling process is controlled by a syringe pump (not shown) comprising a syringe and electronically controlled means for driving the plunger of said syringe. The syringe pump provides an accurate means of sampling and dispensing a blood sample.

Figures 2 and 3 assist with describing and understanding the sampling process. As shown, the apparatus includes a crane portion 42 which moves along linear bearing track 43 by the operation of lead screw 44 driven by a stepper motor 45. As shown in Figure 3, bearing carriages 46 guide the crane portion 42 along the linear bearing track 43. The sampling needle 17 is carried on the crane portion 42 and moves upwardly towards the sampling tube in the carousel as the crane portion 42 is driven upwardly. A needle wash 47 also slides relative to the linear bearing track 43 by the aid of another bearing carriage 48. As shown in Figure 3, the needle wash 47 is biased upwardly and away from the crane portion 42 by a spring 49. However, the needle wash 47 is connected to the crane portion 42 by the lug plate 19. The lug plate 19 includes a slot 50 through which extends a stop member 51 fixed to the crane portion 42. The lug plate 19 is slidable relative to the crane portion 42, the limits of the sliding movement determined by the ends of the slot 50.

The lug plate 19 also includes lug 52. The flexible stripping plate 18 including two vertically aligned slots 53 is connected to the chassis of the apparatus. A cam roller 54 is mounted on the crane portion 42. During initiation of the sampling process, the crane portion 42 will be located at the central position as shown in Figure 3. In this position, lug 52 is prevented from moving downwardly

to any degree by stripping plate 18. In the relative positions of the needle wash 47 and needle 17, the needle is received within the needle wash 47. As downward movement of the crane portion 42 and hence the needle 17 is prevented, the needle is locked in this position.

As the crane portion 42 is driven upwardly by the lead screw 44, the needle wash 47 will bear against the cap of the sample tube 16 in the carousel 15. As the needle 17 continues to progress upwardly with the movement of the crane portion 42, the lug plate 19 which is held against the tube cap will move downwards relative to the crane portion 42 and the needle will extend through a hole 55 provided in the needle wash and out the other side to pierce the cap of the sample tube. The syringe pump operates so as to draw a sample of blood from the tube and into a holding coil (not shown).

Extending upwardly from the needle wash 47 is a tongue 56 which enters the tube station of the carousel and prevents rotation of the carousel during the sampling process.

As the sampling needle 17 is removed from the tube cap, by the downward action of the crane portion 42, the tube cap continues to be supported by the needle wash 47. This prevents the needle from pulling the caps off tubes and spilling the blood sample. However, tubes may be slightly withdrawn from the carousel 15 by the process of withdrawing the sampling needle 17. Once the sampling needle is fully withdrawn from the tube cap, the action of the spring 49 ensures that the needle wash 47 pushes the blood sample tubes back into the carousel 15. As the crane portion 42 progresses downwardly, the cam roller 54 flexes the stripping plate 18 rearwardly until the cam roller 54 moves into the lowermost of slots 53 and the lug 52 is received in the uppermost of the slots 53. In this position, the sample dispensing pipette 20 is washed in pipette wash station 57.

Following sampling, the sample tube 16 is ejected from the carousel 15 by an ejection mechanism (now shown). The ejection mechanism comprises a tag driven by a lead screw (not shown) which pushes the sample tube out of the carousel and into a chute or bin (not shown). The ejection mechanism is provided at an eject station arranged a few stations beyond the sampling station as the carousel rotates.

The sample path valves (not shown) are then manipulated so that the sample may now be passed to the sample dispensing pipette 20. The syringe pump (not shown) is then commanded to pump the sample to the sample dispensing pipette 20. At this time the waste liquid system valves are manipulated so that any liquid so dispensed is drawn to the internal waste liquid reservoir in the apparatus. The syringe pump is then commanded to pump a portion of the sample from the holding coil to waste. This action results in unadulterated blood being presented to the sample dispensing pipette 20. The sample dispensing pipette 20 then moves up and out of the pipette wash station 57 and is positioned so that a slide may be presented.

Following label printing, the slide transport platen 12 moves so as to position the slide under the sample dispensing pipette 20. The sample dispensing pipette 20 approaches the slide and stops at a commanded position. The syringe pump is then commanded to dispense a known volume of blood onto the slide. The sample may be dispensed in the form of a round drop or a streak or otherwise.

Next the support arm 31 rotates about a vertical axis so as to move the smearer chuck 30 and smearer element 29 from a position above the smearer wash station 58 to a position above the axis of travel of the slide transport platen 12. The smearer chuck 30 is then caused by a motor (not shown) to rotate from its vertical position to a near horizontal position.

The slide transport platen 12 moves the slide and blood sample to a position below the smearer chuck 30. The smearer chuck 30 is rotated back towards its rest position so that the smearing element 29 rests upon the upper surface of the slide at a predetermined angle. A spring provides a known contact force between the smearing element 29 and the slide surface. Free rotation of the smearer chuck along its axis ensures that the free end of the smearing element 29 is in full contact with the slide surface. The slide transport platen 12 then moves relative to the smearing element so as to bring the blood sample into contact with the smearing element 29. The slide transport platen 12 is maintained in this position for a commanded length of time to allow the blood sample to be drawn across the width of the smearing element 29 by capillary adhesive forces. Once the blood sample is drawn across the width of the smearing element 29 the slide transport platen 12 then moves away

from the point of deposition of the sample, drawing the blood along the slide, and depositing a thin film of blood on the slide surface. The velocity, acceleration and displacement of the slide transport platen 12 relative to the smearing element are determined to produce excellent quality blood films over a wide range of haematocrit values. The smearer chuck 30 is then caused by a motor (not shown) to rotate from the smearing position to a position near horizontal.

The slide transport platen 12 then moves away from the smearing position until it reaches the slide transfer position at which point the slide is transferred from the slide transport platen 12, to the rack loading head 13, for subsequent transfer to a slide staining rack 25. The transfer of the slide is achieved by tilting the slide transport platen 12 into a vertical orientation with the slide now held between the slide transport platen 12 and the rack loading head 13. The movement of the slide transport platen 12, a cam (not shown) fixed to the apparatus chassis, and a follower 60 attached to the slide transport platen 12 produce the rotation of the slide through 90°.

Slide transfer is achieved by manipulating the vacuum valves supplying vacuum to the slide transport platen 12 and the rack loading head 13 so that handover of the slide is achieved. The slide transport platen 12 then moves to its home position, returning to a horizontal orientation in the process.

The rack loading head 13 moves down so as to lower the slide into one of a plurality of slide retaining features in a slide rack 25 presented by the rack indexing mechanism 28 beneath. The slide is dropped into the slide rack 25 by disconnecting the vacuum supply from the rack loading head 13.

The rack loading head 13 returns to its home position (as shown) in Figure 1. The rack indexing mechanism 28 moves the slide rack 25 a distance equal to the pitch spacing between slide rack retaining features so that a subsequent slide may be loaded.

The support arm 31 now rotates so that the smearing element 29 is above the smearer wash station 58. The support arm 31 is lowered so that the smearing element 29 is positioned in a cavity in the smearer wash station 58. The smearer element 29 is then rinsed by application of rinse solution. The rinse solution is

removed by way of vacuum and deposited in the internal waste reservoir. The smearer element 29 is then air dried by passing it through an airstream, the motion being provided by moving the support arm 31. The smearer element then returns to its home position (as shown) in Figure 1.

Periodically the smearer element 29 may also be cleaned using a smearer clean solution. At this time the smearer element 29 is lowered into a smearer clean reservoir 59. The smearer element 29 is then rinsed again as described previously.

Referring again to Figure 1, the sample dispensing pipette 20 moves so as to be located inside the pipette wash reservoir 57. The pipette is washed both internally and externally. Internal washing is achieved by commanding the syringe pump to pass rinse solution through the pipette. External washing is achieved by spraying the outer surface of the pipette. The rinse solution is removed by vacuum and deposited in the internal waste reservoir.

The aspirator needle 17 is enclosed by the needle wash 47 when at its home position. The needle 17 is rinsed in the same manner as the dispensing pipette 20 in pipette wash reservoir 57.

The tube loading carousel 15 rotates to present the tube just sampled to the tube ejection mechanism (not shown) located behind the carousel 15. The tube is then ejected from the carousel into a bin for collection by the user.

The above process, commencing with the pickup of a slide from the slide hopper 10, repeats until there are no more samples to process or until the slide rack 25 on the rack indexing mechanism 28 is full. The rack indexing mechanism 28 then moves to the slide rack pickup position. The staining robot 21 then moves to the rack indexing mechanism 28 and picks up the slide rack 25. The slide rack 25 is then placed sequentially into a series of staining solutions contained by some or all of the staining tubs 22. The order of placement of the slide rack 25 into solutions, and the duration of residence, are programmable and controlled by the microprocessor controller. More than one rack may be processed simultaneously. Multiple staining protocols may be run simultaneously.

After the slides have been stained according to the prescribed protocol the slide rack 25 may be optionally transferred by the staining robot 21 to either the

water wash station 23 or the drying oven 24. The wash station 23 comprises a vessel that is supplied with water from a laboratory water supply via a plumbed hose and pressure regulator. A solenoid valve (not shown) controls the flow of water to the vessel so that water only flows when it is required. Water passes over the slides and slide rack 25 and flows to drain via a hose. Level detection in the water wash station 23 detects overflow should it occur and closes the water supply valve.

The drying oven 24 is a programmable, microprocessor controlled device comprising a cavity into which the slides and slide rack 25 are placed, a heating element, and a fan. The instrument microprocessor controls the temperature of the heated air as commanded by the user.

After staining and optional rinsing and drying the slides and slide rack 25 are picked up by the staining robot 21 and placed onto the rack/slide output conveyor 27. The slides and slide rack 25 are then moved to the front of the instrument for collection by the user.

The sequence of operations described is representative of a process where operations are performed sequentially. In reality operations will in many cases be preformed in parallel in order to shorten the cycle time of the instrument.

CLAIMS:

1. A closed tube sampling apparatus for drawing a specimen sample from a sample tube having a pierceable cap, said apparatus including a sample tube loading carousel for supporting sample tubes radially on said carousel, characterised in that, said carousel is adapted to index said tubes in turn to an aspirate position; said apparatus further including a needle carrier moveable linearly from a park position to a range of operative positions located towards said carousel, said needle carrier including an aspirator needle for piercing said cap and drawing a sample; and a tube support member moveable linearly relative to said needle carrier towards and away from said carousel and being adapted in an extreme position in one direction to prevent withdrawal of said cap and tube from said carousel during sampling.

2. An apparatus according to claim 1, characterised in that, said tube support member comprises a needle wash station having an aperture therethrough for passage of said needle, the active part of said needle being accommodated in said needle wash station when said needle carrier is in said park position.

3. An apparatus according to claim 2, characterised in that, said needle carrier includes a first locking means which is effective at the park position of the needle carrier for locking said needle within said wash station.

4. An apparatus according to claim 2 or 3, characterised in that, said needle carrier includes a sample dispensing pipette in fluid communication with said aspirator needle via a syringe pump and holding coil, said sample dispensing pipette being adapted to receive said sample from said holding coil and dispense the sample onto a slide.

5. An apparatus according to claim 4, characterised in that, a pipette wash reservoir is spaced below said sample dispensing pipette such that when said needle carrier is in an extreme position in the other direction said sample dispensing pipette is in said pipette wash reservoir.

6. An apparatus according to claim 5, characterised in that, said needle carrier and needle wash station are separately mounted for said linear movement on a linear bearing track and are interconnected in a manner allowing limited said relative linear movement, and a spring member is connected between said needle

carrier and needle wash station to bias said needle wash station against said cap during said sampling.

7. An apparatus according to claim 6, characterised in that, said needle wash station includes a second locking means in the form of a tongue which extends into said carousel when said needle wash station is in said extreme position in one direction, to prevent rotation of the carousel during sampling.

8. An apparatus according to claim 1, characterised in that a bar code is present on each said sample tube to identify the sample and the bar code is read by a bar code reader whilst said sample tube is in said aspirate position on said carousel.

9. A slide transfer apparatus for transferring slides from a stack of slides to a slide conveyor, characterised in that, said apparatus includes a pickup head for picking up the top slide from a stack of slides and returning to a home position, a slide transport platen for movement under said pickup head to receive a slide from said pickup head, and a sensor on said pickup head to determine when said slide is released from said pickup head onto said platen and facilitate determination of whether one slide or several adhered slides are released onto said platen.

10. A slide transfer apparatus according to claim 9, characterised in that, said sensor is an optical sensor having a beam which is broken by a plunger on said pickup head, which plunger moves relative to said sensor as said pickup head releases and moves away from a slide on said platen, the amount of movement necessary to activate said sensor determining whether one or two slides have been released onto said platen.

11. A slide transfer apparatus according to claim 10, characterised in that said plunger is a spring loaded plunger which bears on a slide held by said pickup head and is thereby retracted into said pickup head and extends out from said pickup head when no slide is present, a stem of said plunger breaking said beam when said plunger is retracted and avoiding said beam when said plunger extends.

12. A slide transfer apparatus according to claim 11, characterised in that said pickup head includes a bellows type suction cup recessed into said pickup head, said cup extending slightly outwardly beyond the surface of said pickup head in its

extended or natural state and retracting into said head when it is evacuated and holding a slide.

13. A slide transfer apparatus according to claim 12, characterised in that a second optical sensor is provided at said home position of said pickup head to determine when said pickup head is in said home position, said apparatus further includes a lead screw driven by a stepper motor to move said pickup head and a microprocessor for determining the rotational movement required by the stepper motor whereby the distance between the home position and the top slide of said stack, and the home position and the slide transport platen is calculated.

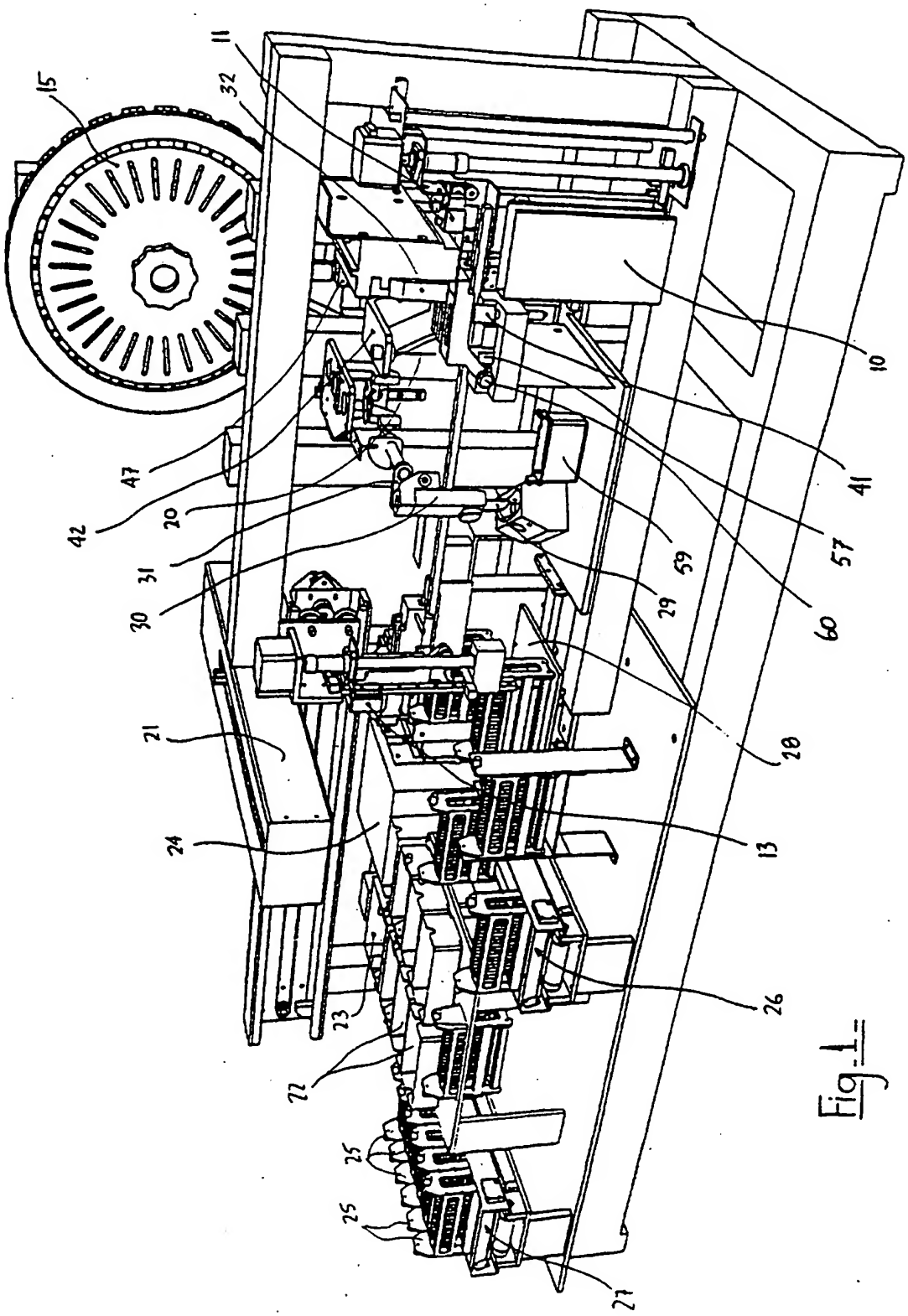

Fig-1

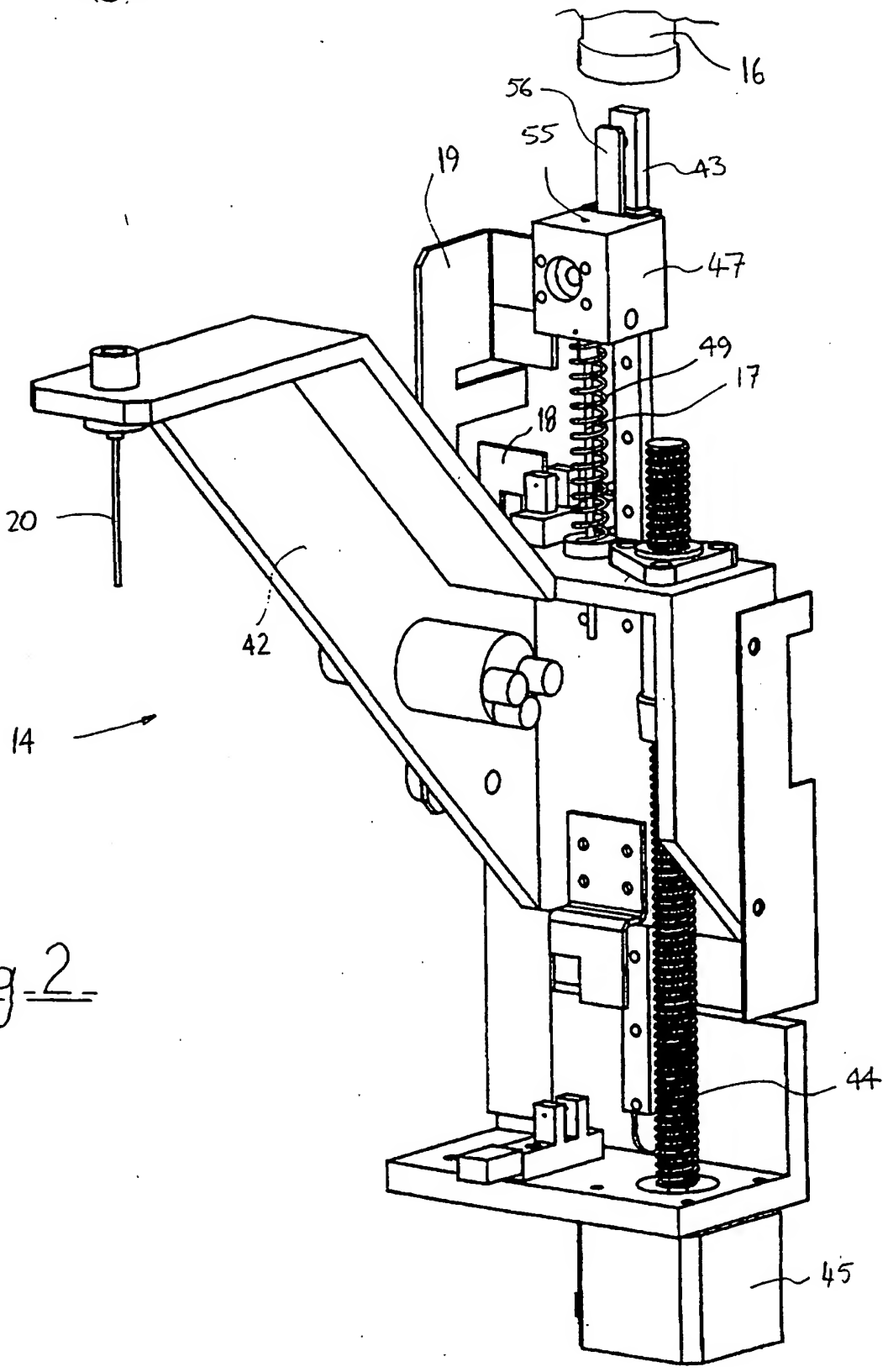

Fig 2

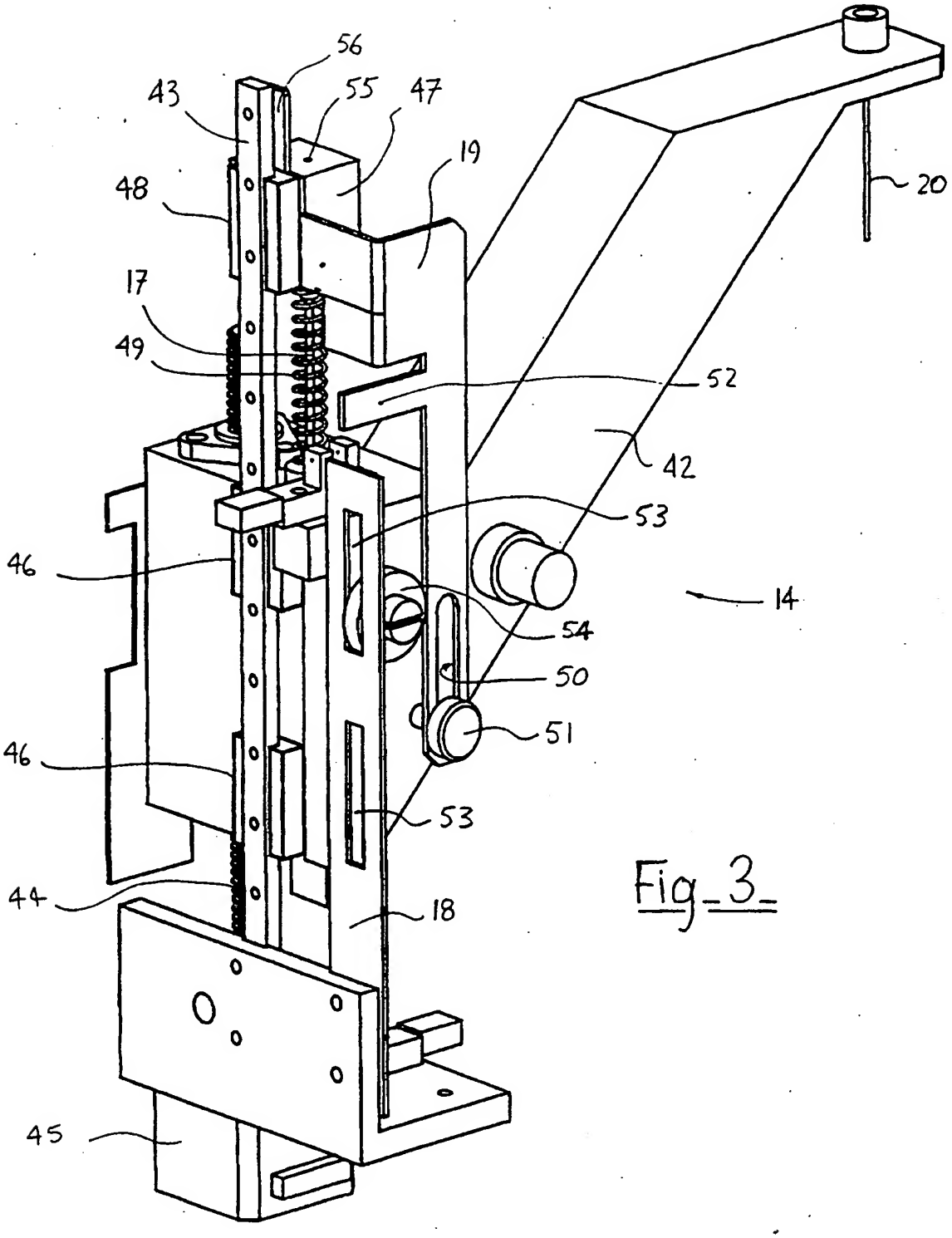

Fig 3

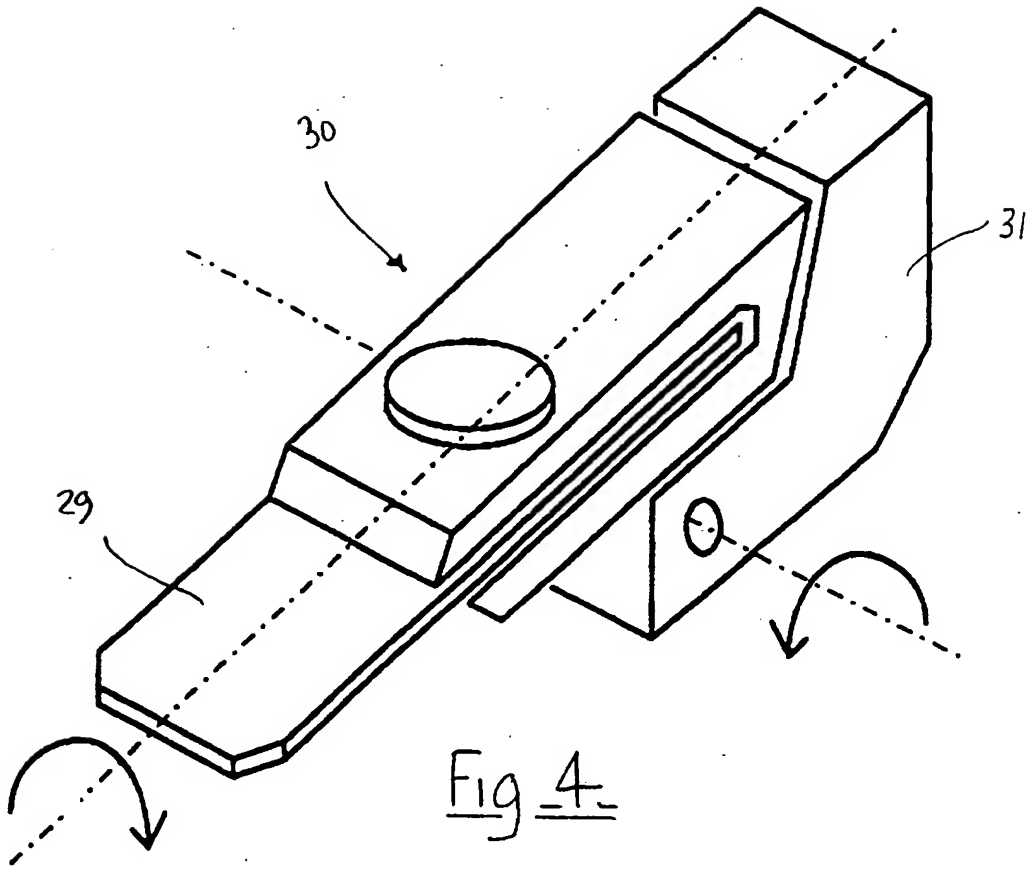

Fig 4

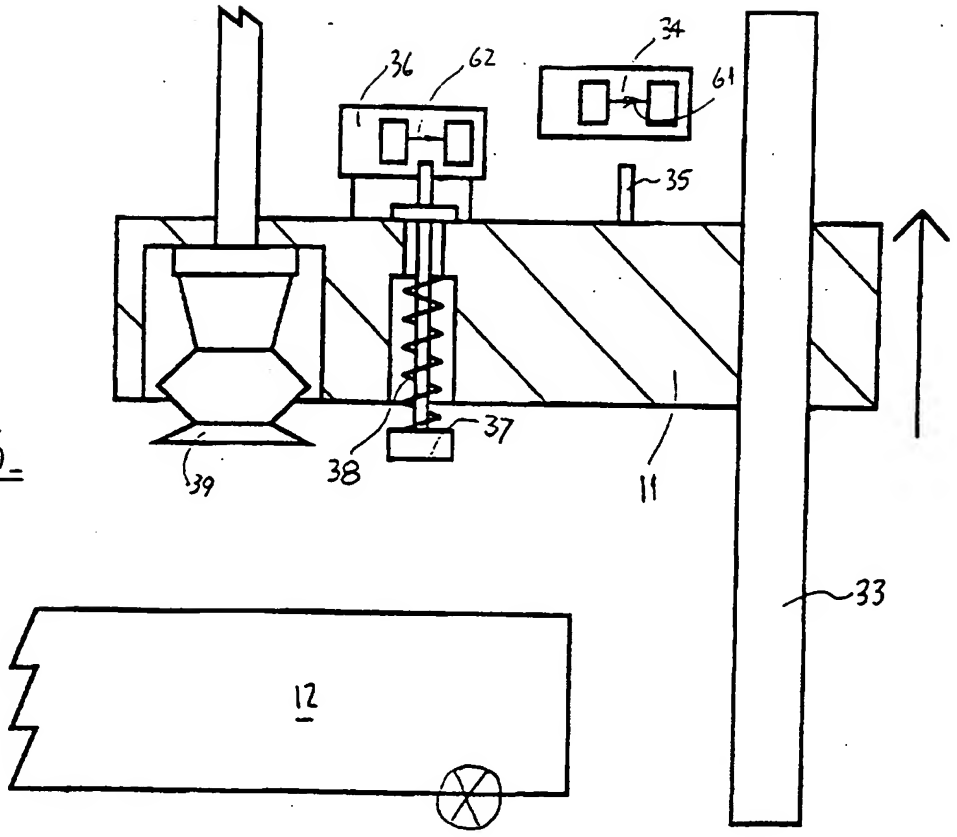

Fig. 5.

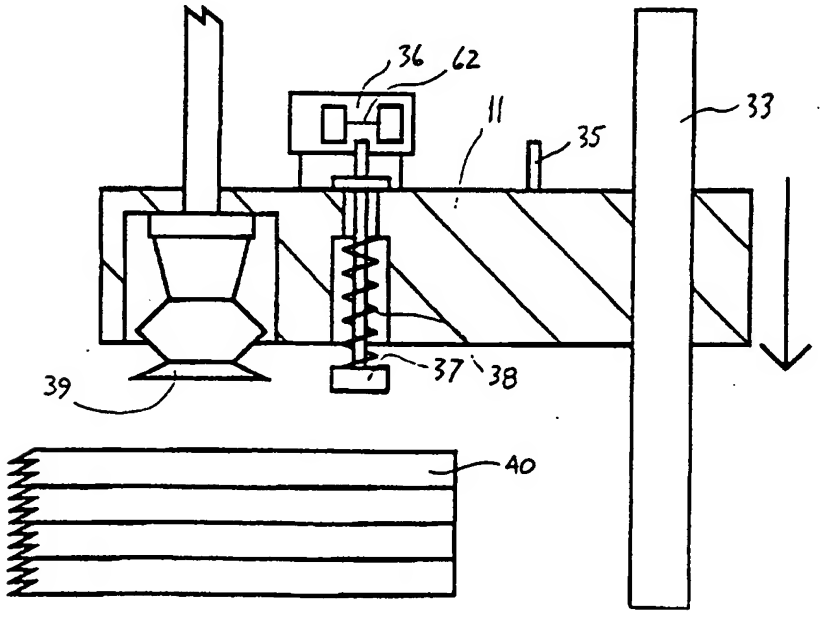

Fig. 6.

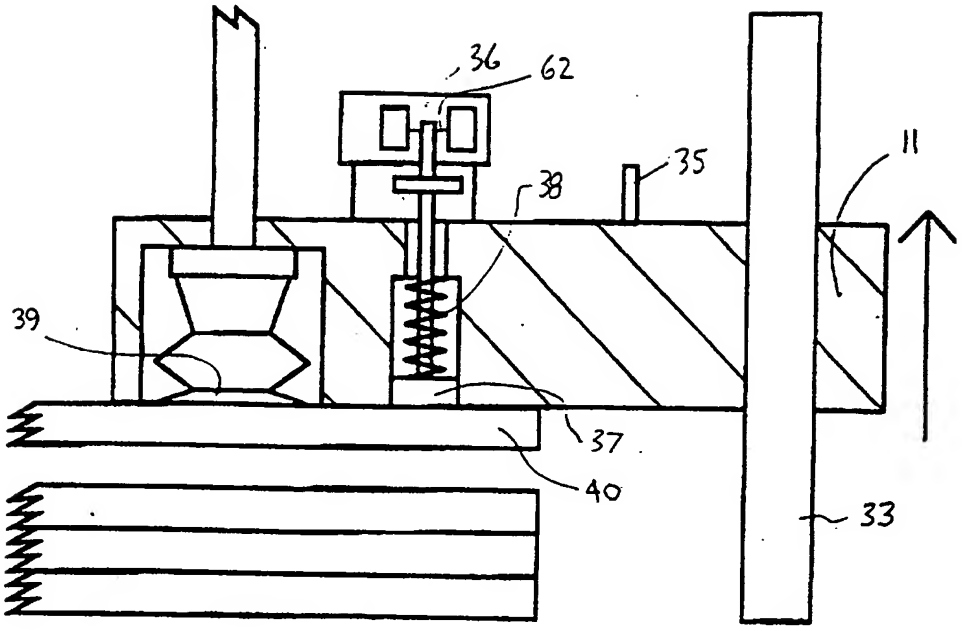

Fig. 7.

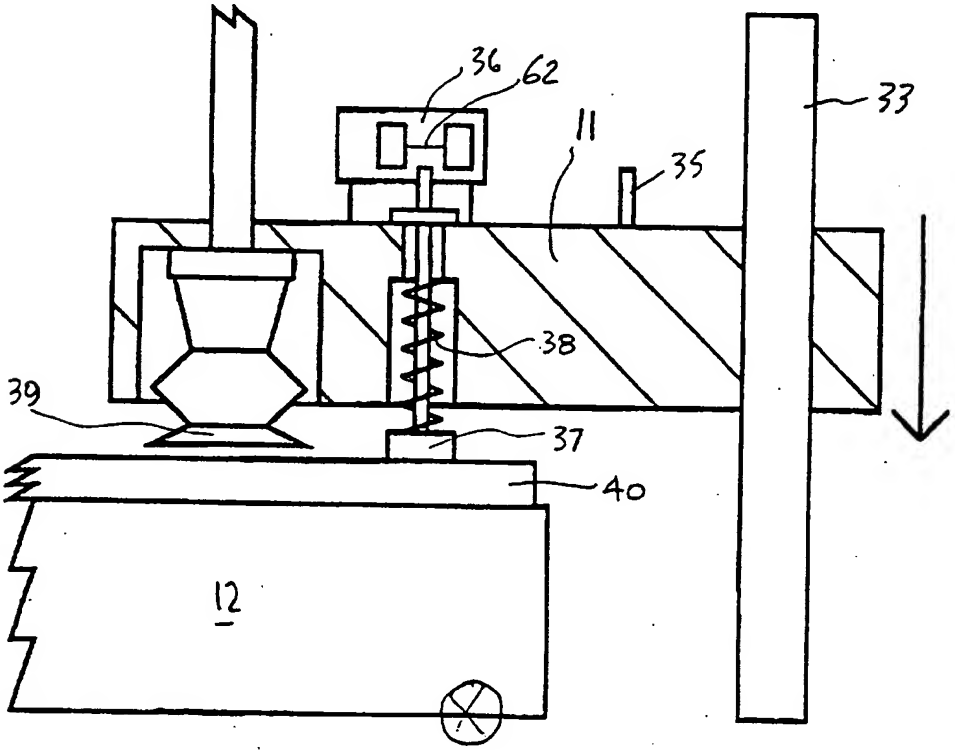

Fig. 8.

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 97/00027

A. CLASSIFICATION OF SUBJECT MATTER

Int Cl[6]: G01N 35/02, 35/10; G02B 21/34; B65H 3/64

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: G01N 1/16, 35/00, 35/02, 35/10; G02B 21/34; B65G 47/68, 47/91, 49/06, 59/04, 61/00; B65H 3/10, 3/34, 3/64

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

AU: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

DERWENT, JAPIO [(TUBE OR CAP), (CAROUSEL OR INDEX), (NEEDLE OR SYRINGE), SLIDE]

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2095403 A (COULTER ELECTRONICS LTD) 29 September 1982 See Abstract, page 5 lines 30-48, page 7 line 57-page 9 line 2, figure 24	1-8
A	WO 91/13335 A (IMMUNO DIAGNOSTICS, INC) 5 September 1991 See Abstract, page 25 lines 16-27, figure 3	1-8
A	US 5324479 A (NALDONI) 28 June 1994 See Abstract, column 10 line 59-column 11 line 37, figure 11	1-8

[X] Further documents are listed in the continuation of Box C

[X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
7 March 1997	12.03.97
Name and mailing address of the ISA/AU AUSTRALIAN INDUSTRIAL PROPERTY ORGANISATION PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No.: (06) 285 3929	Authorized officer STEPHEN CLARK Telephone No.: (06) 283 2164

Form PCT/ISA/210 (second sheet) (July 1992) copbko

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 97/00027

C (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4166094 A (FROEHLICH) 28 August 1979 See Abstract, figure 2	1
A	EP 645631 A (BECTON DICKINSON & CO) 29 March 1995 See Abstract, column 11 lines 2-14, figures 2, 3A	1-8
A	AU 62356/86 A (TECHNICON INSTRUMENTS CORPORATION) 5 March 1987 See pages 4-8, figure 1	1-5
A	DE 2918699 A (CENTRO TECHNOLOGICO ITALIANO S.A.G.) 15 November 1979 See Abstract	9
A	EP 458138 A (TECHNICON INSTRUMENTS CORPORATION) 27 November 1991 See Abstract	9
A	US 4171241 A (HENDERSON et al.) 16 October 1979 See Abstract	9
A	US 3972423 A (TIPTON) 3 August 1976 See Abstract	9
A	US 3880111 A (LEVINE et al.) 29 April 1975 See Abstract	9
A	Derwent Abstract Accession No. 92-410918/50, Class SO3, JP 04-307366 A (HITACHI LTD) 29 October 1992 See Abstract	9
A	Derwent Abstract Accession No. 86-059952/09, Class SO3, JP 61-013158 A (KONISHIROKU PHOTO KK) 21 January 1986 See Abstract	9
P,A	WO 97/00461 A (AUSTRALIAN BIOMEDICAL CORP LTD) 3 January 1997 See Abstract	9

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 97/00027

Box 1 Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Claims 1-8 are directed to a sampling apparatus which provides a needle to pierce the cap of a closed tube and draw the sample out. A radial loading carousel for the tubes is present.
Claims 9-13 are directed to a slide transfer apparatus, associated with a conveyor, for picking up slides from a stack and transferring to the conveyor. A sensor is also present to determine if multiple slides are picked up.

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☒ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No.
PCT/AU 97/00027

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
GB	2095403	AU	81676/82	CA	1184785	EP	61317
		JP	57211068	SE	8101788	US	4475411
WO	9113335	CA	2077452	EP	517835	US	5595707
US	5324479	EP	353206	IT	1224861	PT	91321
US	4166094	AU	39293/78	CA	1084297	DE	2828436
		GB	1596868	IT	1116186	JP	54153693
AU	62356/86	BR	8604194	CA	1292371	DK	4175/86
		EP	220430	ES	2002324	JP	62110158
		US	4799393	US	4756201	US	4811611
DE	2918699	IT	1113068				
EP	458138	AU	73599/91	CA	2036161	IL	97263
		JP	4357460	US	5075079		
US	4171241	DE	2809510	FR	2382391	GB	1597954
		JP	53109377				
US	3972423	GB	1457137	US	4033809		
US	3880111	CA	983360	DE	2452267	FR	2250113
		GB	1458605	JP	50073731		

END OF ANNEX